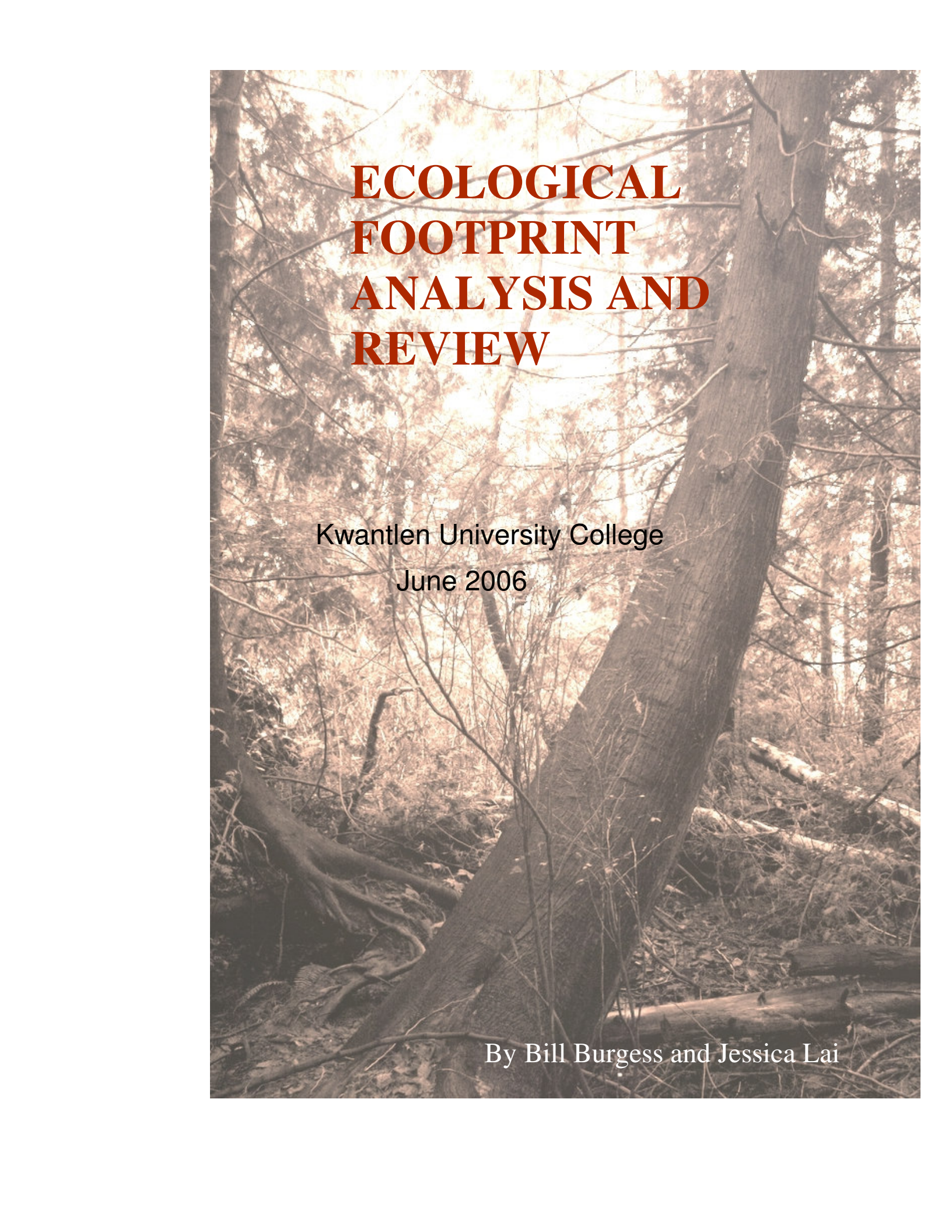




ECOLOGICAL FOOTPRINT ANALYSIS AND REVIEW

Kwantlen University College

June 2006

By Bill Burgess and Jessica Lai

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Photo Site: Forest North of Building D – Surrey Campus
Photo Credit: Tom Knox

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How much land is used by Kwantlen University College?

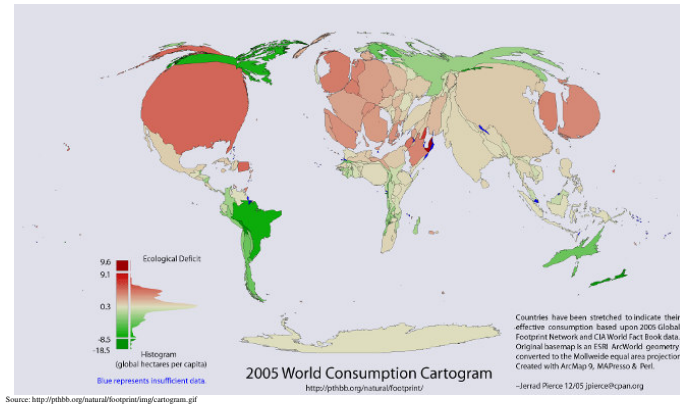
What exactly is an 'ecological footprint'?

As depicted by the graphic¹ below, the size of the footprint expresses how much of the earth's surface is needed to sustain a given population at its current level of consumption.²

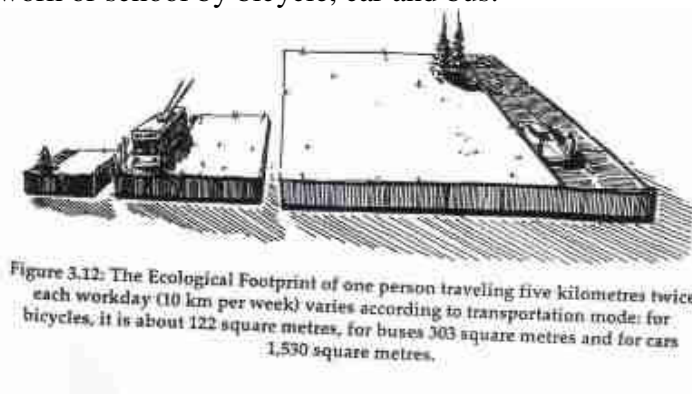


This concept was developed by William Rees and Mathis Wackernagel at UBC. It highlights the global impact of our activity, and it makes it possible to compare the sustainability of different lifestyles and activities. The results are highly educational.

For example, footprint calculations indicate that several more earth-like planets would be required for the the rest of the world to adopt the consumption patterns of the now-rich countries. As illustrated by the cartogram below, most rich countries "live off" an area that is far greater than their own territory. Canada's vast area relative to population does leave us 'in the green', but this is hardly an excuse for our leading the world in per capita energy consumption.



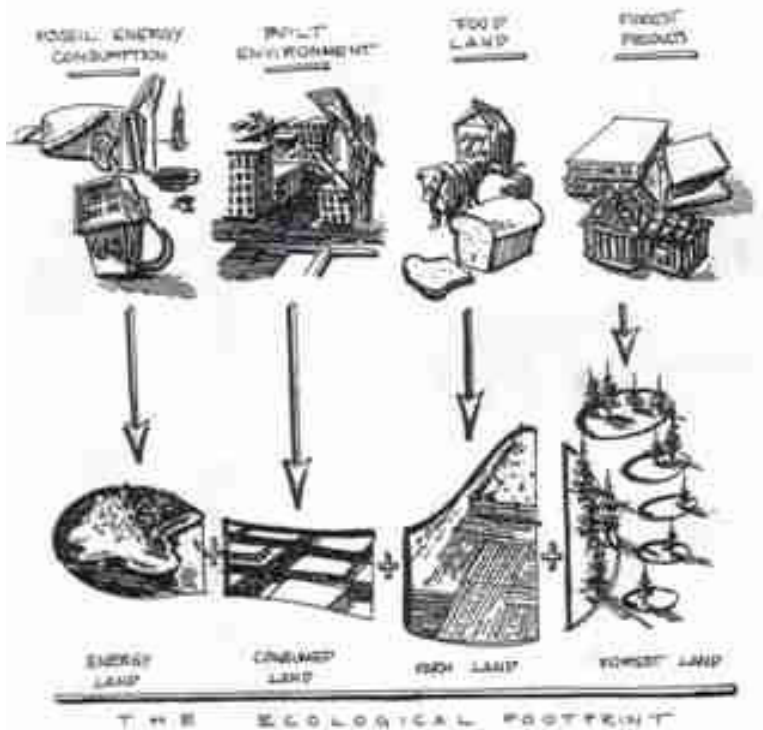
Ecological footprints have been calculated at many scales: global, by country, regional, urban, individual and even for particular activities.³ Footprint calculations over time make it possible to track progress (or regress) in sustainability. The graphic below⁴ compares the footprint of commuting to work or school by bicycle, car and bus.



How are footprints calculated?

In general, ecological footprints are calculated by estimating the land area required to support four main categories of final consumption, as expressed by the graphic below.⁵ These categories are far from exhaustive, but they include the main demands we place on our planet.

The first category is 'energy' land, expressed by the area somewhere on earth that is needed to absorb our emissions of carbon dioxide from energy consumption.⁶ The second category is the area required to grow food and fibre. This in turn is subdivided into various land types (cropland, grazing land, etc.). The third category is the land required to produce the main materials devoted to our consumption, such as metals, plastics, wood and paper, etc. The fourth category is the built-up land (buildings, roads, etc.) that is thus no longer bio-productive.



In each case, the footprint for that category of activity is calculated on the basis of the bio-productivity of the different types of the land necessary to sustain it. The different types of land are then converted the common metric of 'global hectares', a hectare of land somewhere in the world of average bio-productivity.⁷

Calculating the Kwantlen ecological footprint

Kwantlen has now joined a number of universities and colleges for which footprints have been calculated. Our urban geography class adapted a spreadsheet for use at KUC that was originally developed by Chelsea Stewart and Jennifer Loo to calculate the ecological footprint of their University of Toronto Mississauga (UTM).⁸

While the concept of ecological footprints is relatively simple, they are very demanding in terms of data. The UTM spreadsheet greatly facilitated our data collection by organizing it terms the information available from various departments of the university. The spreadsheet also includes the conversion ratios between various activities and the hectares of land somewhere in the world needed to support them. Most of the conversion rates are taken from the expert calculations in Rees and Wackernagle's Our Ecological Footprint, or Sharing Natures Interest by Chambers, Simmons and Wackernagle.⁹

Geog 2250 members collected the relevant data and converted it as necessary into the appropriate physical units. These values were then multiplied by the UTM-provided conversion ratios to obtain the footprint areas. The derivation of the ecological footprint area for each consumption category is reported in the Appendix. The process can be illustrated by the example for paper summarized below.

Ecological footprint of paper

It should first be noted that we were not able to include all paper consumption on campus. Our coverage includes the copy paper used by the Kwantlen Student Association (KSA), printing paper by the KUC Printing Department, and toilet paper and paper towels used in KUC washrooms.

The ecological footprint for paper represents two types of land: the 'forest land' needed to produce the fibre, and the 'energy land' needed to absorb the CO₂ produced by energy used to manufacture the paper.

According to our UTM sources, it takes 1.8m³ of wood to produce one tonne of virgin paper, and this can be grown on .904 hectare years of 'forest land'. However, a hectare of forest land is 1.17 times as bio-productive as a 'world hectare', so the 'forest land' required for one tonne of virgin paper can be expressed as 1.06 world hectare years.

Producing one tonne of virgin paper also requires 25 GJ of energy, and this requires .9106 world hectare years.¹⁰ The combined 'forest' and 'energy' footprint of one tonne of virgin paper is thus 1.97 world hectares. Paper made from 100% recycled fibre does not require additional forest land, and only 30% of the energy used to produce virgin paper, so the footprint for a tonne of recycled paper is .27 world hectares.¹¹

The Kwantlen Student Society (KSA) reported they used 6,400 reams of paper. The KUC Printing Department reported using 20 million sheets of paper, or an estimated 40,000 reams of paper.¹² The latter began using paper with 30% recycled fibre in September, 2005, so we expressed this as an annual rate of 10%.¹³ There are an estimated 435 reams of paper in a tonne of paper. Multiplying the KSA and Printing Dept. consumption of virgin paper and recycled paper times their respective world hectare conversion rates yields an estimated ecological footprint for printing paper of 194.7 world hectares.¹⁴

The reported consumption of toilet paper and paper towels in KUC washrooms in 2005 was 10.93 tonnes of paper towels and 5.67 tonnes of toilet paper, for a total of 16.60 tonnes.¹⁵ The paper towels are manufactured from 40% recycled fibres, so the 26.43% of total washroom paper was recycled fibre. Multiplying the virgin paper and recycled paper times their respective conversion factors yields a footprint for washroom paper of 25.26 hectare years.

The combined ecological footprint for printing and washroom paper was therefore 219.96 world hectares.¹⁶

Data limitations

There are, of course, limitations to our calculations, mainly because not all the data necessary for complete coverage of each consumption category was available.

The most serious data deficit is in the area of transportation. We relied on a very small sample for information on modes of travel. We had to guesstimate the distances travelled to campus, the KUC share of car use, and the KUC share of BC road space (see Appendix for details).

The only materials category for which we could obtain data was paper, and it did not cover all departments. We could not address other major materials, notably metal, glass, and plastic, or the extent to which they are recycled.

Our calculation for food relies on data that is likely for the original foodstuffs themselves and may not reflect packaging or secondary processing. We also did not consider food or drinks sold from vending machines.

Comparison of campus footprints

Our results can be compared to footprints that have been calculated for other campuses, bearing in mind that there are significant differences in coverage and calculation methods.

For example, the table below indicates that the KUC per capita footprint is significantly smaller than that for UTM. Our coverage was less than for UTM, but the main reason for a smaller footprint is probably that KUC requires less energy for heating. Further, our electricity is mainly generated by hydro while the UTM in Ontario relies more on coal and nuclear, which have larger footprints.

KUC has also carried out a significant program to reduce energy consumption in recent years. Since 1994, gas consumption has actually gone down even though building size has risen by 10% and students enrolment by 40%.¹⁷ Changes in atrium and outdoor lighting have reduced electrical power consumption and total costs. New buildings now under constructions will be partly heated and cooled with geo-thermal energy, which has a minimal ecological footprint.

Ecological footprints of six universities

Institution	Location	Year	Campus Population	Students in residence	Categories included	Total footprint (ha)	Per capita footprint (ha)
Kwantlen	BC, Canada	2005	17,734	none	Paper, energy, cafeteria food, transportation, water, built-up land	3039	0.33
UTM (U. Toronto Miss.)	Ontario, Canada	2005	7509	1023	Materials and waste, energy, food, transportation, water, built-up land	7826	1.04
Univ. of Newcastle	Newcastle, Australia	1998-1999	Over 19200	800	Food, energy, transportation, goods, services, built-up land	3592	0.19
Holm Lacey College	Herefordshire, UK	2001	524	No data	Energy, transportation (staff only), water, waste, food	296	0.56
Colorado College	Colorado, USA	2001	Approx 2500	No data	Energy, transportation (fleet and ground only), food, water, built-upland	5602	2.24
Univ. of Redlands	California, USA	1998	2725	No data	Water, waste, energy, transportation	2300	0.85

Source: Kwantlen data from above; for other campuses from Table 1 in Chelsey Stewart and Jennifer Loo, *Ecological Footprint Progress Report, 2005*, at <http://geog.utm.utoronto.ca/conway/ecofoot/mainframe.htm>

Recommendations

A number of recommendations emerged from our work on the KUC ecological footprint. The following were points of rough consensus among Geog 2250 members.

1. Transit:

Our main recommendation is that transit services must be improved so that more students and staff can commute by transit rather than private automobile. This could be advanced by introducing an attractive U-Pass system for all campus members. U-Passes at SFU and UBC have significantly increased transit ridership. Increasing transit ridership is, in turn, key to improving the frequency and general quality of transit services south of the Fraser river.

This is a multi-campus institution. Some students and staff live reasonably close to one campus, but have to rely on private cars to travel to between campuses. A shuttle bus service between campuses should be considered by KUC or Translink.

2. On campus energy

We were pleased to see that it appears that real effort is being put into energy conservation by the KUC Facilities Dept., showing how this really is possible. However, more can be done. Additional buildings should be 'green' buildings. Kwantlen can do more to promote alternative energy, e.g., as a resource for the community and given the expertise available within our technical programs, experimental or demonstration energy conservation projects should be undertaken, such as solar hot water heating (for washrooms and the horticulture greenhouses?), photovoltaics (for some lighting) and perhaps wind energy.

3. Materials and recycling

The Kwantlen print shop has begun using some paper manufactured from recycled fibre, and some washroom papers contain recycled fibre. However, we noted that the Kwantlen Student Society (KSA) does not seem to purchase paper made from recycled fibre and we strongly recommend this be done.

We were unable to determine how much other material (metal, glass, plastic, electronic components etc.) is currently recycled at KUC. However, it is our impression that more can be done to recycle materials, and we recommend a comprehensive review of materials use.(see our recommendation below on gathering data).

4. Water

Fountains are not widely available on our campuses. This results in students and staff buying water from vending machines, where - wastefully packaged in bottles - it costs more per litre than gasoline. The progressive commodification of this public good is part of our wider pattern of often-mindless consumerism. We recommend that KUC provide water fountains in all areas of the campus, notably in all new buildings.

5. Data collection

First of all, we recommend that further KUC ecological footprints be calculated. Our effort was very much a ‘first approximation’. Future efforts should check our results for errors and omissions, and extend the calculations to include areas we did not address, such as the other material categories. Footprints should be calculated annually, to track changes over time, and to identify opportunities to increase campus sustainability.

We strongly urge that KUC undertake a comprehensive transportation survey of students and staff. The Office of Institutional Research does not seem to have collected data from which estimates can be made of how far students and staff travel to campus, of trips between campuses, or the modes of travel.¹⁸ This information is necessary to calculate the KUC footprint and it should also be collected in order to clarify the potential for increasing the use of transit, including the feasibility of the U-Pass program and shuttle buses. It is also necessary in order to advocate publicly for such programs.

A survey should be carried out of materials use, recycling and waste, to identify their extent and possibilities for reducing use, increase recycling and reducing waste. Students could carry out such surveys as part of their course-work or be employed to carry it out and prepare reports under the direction of the Facilities Department.

Acknowledgements

It would not have been possible for Geog 2250 to complete our estimate of the Kwantlen ecological footprint without the generous assistance from Karen Hearn, Director of Facilities Department. At her request, several Facilities Department staff provided us information, notably Tom Knox, Barry Mohring and Scott Gowen. Bruce Engleton of Imperial Parking Ltd. and Gordon Barber of Chartwells Ltd. also kindly provided us with information at Ms. Hearn’s request. Various members of Geog 2250 were assigned to collect various areas of data and convert it to the required units. The demand on the time of our informants was minimized by centralizing most of our requests through the class instructor, Bill Burgess. This report was drafted by Bill Burgess drawing on papers by Geog 2250 students, with sections on the calculations drafted by Geog 2250 student Jessica Lai.

Endnotes

¹ Graphic from William Rees and Mathis Wackernagle, 1996, Our Ecological Footprint, Gabriola Island: New Society Publishers.

² William Rees defines the ecological footprint as “the area of land and water ecosystems required on a continual basis to produce the resources that the population consumes, and to assimilate (some of) the wastes that the population produces, wherever on Earth the relevant land/water may be located” in his “Ecological Footprint, Concept of”, Encyclopedia of Biodiversity, Vol. 2, pp. 229-244. San Diego: Academic Press.

³ For example, see Redefining Progress’ Footprint of Nations at <http://www.rprogress.org/publications/2006/Footprint%20of%20Nations%202005.pdf> , and a footprint calculation for Toronto at <http://www.toronto.ca/eia/footprint/howbig.htm>.

⁴ Graphic from William Rees and Mathis Wackernagle, 1996, Our Ecological Footprint, Gabriola Island: New Society Publishers. Note that the UTM-provided conversion factor we used was slightly different: the world hectare years required to support a passenger mile travelled by private car was .000928 compared to .0003 for a passenger mile by transit.

⁵ Ibid.

⁶ Energy land could alternatively be calculated as the area of land required to grow crops like sugar cane that can be converted to useable energy like alcohol. However, the latter is generally larger than the former, and the authors of the footprint concept advocate the methods resulting in the most conservative estimate. Another indication of the ‘conservative’ character of footprint calculations is that it is assumed that land is being used on a sustainable basis, which is not always the case.

⁷ The following are equivalence factors representing the relative bio-productivity of different types of land, relative to the ‘world hectare’ unit: Fossil energy land – 1.17; Built-up land – 2.83; Arable land – 2.83; Pasture – 0.44; Forest – 1.17; Sea – 0.06 (as reported by Chelsea Stewart and Jennifer Loo, 2005, User Manual for UTM’s Ecological Footprint, available at <http://geog.utm.utoronto.ca/conway/ecofoot/mainframe.htm> .

⁸ The UTM ecological footprint spreadsheet and related reports (Chelsea Stewart and Jennifer Loo, 2005. User Manual for the UTM’s Ecological Footprint Calculator. Chelsea Stewart and Jennifer Loo, 2005. Ecological Footprint Progress Report) are available at <http://geog.utm.utoronto.ca/conway/ecofoot/mainframe.htm>.

⁹ William Rees and Mathis Wackernagle, 1996, Our Ecological Footprint, Gabriola Island: New Society Publishers; N. Chambers, C. Simmons and M. Wackernagle, 2000, Sharing Nature’s Interest: Ecological Footprints as an Indicator of Sustainability, London: Earthscan Publications.

¹⁰ All conversion rates in this section are taken from Op sit, and in turn are drawn from Ibid. The calculation of energy land is based on the breakdown of energy sources in Ontario grid. The BC grid includes more hydro power (and no nuclear) so the appropriate figure for BC would be smaller.

¹¹ 30% times energy land for virgin paper of .9106 world hectares from above.

¹² For the KSA, for the year 2004, as reported on Feb 15/06 by Meenu of the KSA to Amy McLellan. For the KUC Print Shop, as reported by Scott Gowen, Director of Materials Management in a March 1/06 email to Bill Burgess. We assumed a ream is 500 sheets.

¹³ 4 months/12 months times 30% equals 10%.

¹⁴ The footprint for printing paper = (KSA virgin paper reams/435)*(conversion factor of 1.97)+ (KUC virgin paper reams/435)*(conversion factor of 1.97) + (KUC recycled paper reams/435)*(conversion factor of .273) = (6,440/435*1.97) + (.9*40,000/435*1.97) + (.1*40,000/435*.273)= 194.70 world hectare years

¹⁵ As reported by Barry Mohring, Kwantlen Facilities Manager, in a March 6/06 email to Bill Burgess.

¹⁶ The paper towel share of total washroom paper is 65.86% times 40% recycled fibre = 26.43% of washroom paper from recycled fibre. (KUC virgin washroom paper)*(conversion factor of 1.97) + (KUC recycled washroom paper)*(conversion factor of .273) = (.7357*16.601*1.97) + (.2643*16.601*.273) = 25.26 world hectare years.

¹⁷ According to <http://www.kwantlen.ca/facilities/energy.html#efficiency>.

¹⁸ We reviewed a document titled “Attachment: U-Pass Program Expansion Data” from the KUC Registrar’s Department (November 2004), but it did not really contain the necessary data on how far students commute.

Appendix of data sources and calculation methods

Below is a reproduction of the spreadsheet used to calculate the KUC ecological footprint.

Kwantlen Ecological Footprint Calculator, 2005					
CAMPUS					
			not FTE	FTE	
Number of students	full and part-time		16,471	9,223	
Number of staff	full and part time		455	411	
Number of faculty	full and part time		808	578	
Other					
Total Campus Community Members			17,734	10,212	
KUC Campus department or area	Sub-category	Categories and details	KUC values	Conversion Factor	Footprint (world hectare years)
Chartwells	Cafeterias	Food			
		Seafood (kg)	2,459	0.0045	11.07
		Meat and poultry (kg)	15,598	0.0069	107.63
		Vegetables (kg)	59,916	0.0004	23.97
		Grain (kg)	45,319	0.0017	77.04
		Dairy (kg)	58,086	0.0011	63.89
		Fruits (kg)	18,532	0.0005	9.27
		Paper			
Student Society	Copy paper	Paper use (# reams)	6,440	1.97	
		% recycled	0.0000	0.273	29.17
KUC Printing Dept.	Copy/ printing paper	Paper use (for entire campus) (# reams)	40,000	1.97	
		% recycled (enter as fraction)	0.1000	0.273	165.54
KUC Facilities	Washrooms paper	use (paper towels, toilet paper, etc) (tonnes)	17	1.97	
		% recycled	0.26	0.273	25.28
		Water			
KUC Facilities	Water	Water use (m3)	60,000	0.00008	4.80
		Energy			
KUC Facilities	Terrasen gas	Natural gas (m3)	931,784	0.00047	433.28
	BC Hydro	Hydroelectric (GWh)	7.284000	42.5	309.57
		Natural gas (GWh)		94	0.00
		Coal/oil (GWh)	0.779595	174	135.65
		Built-up land (buildings)			
Campus buildings	Buildings, imp. surf.	Building footprints (square m)	117,966	0.00028	33.38
		Transportation (auto)			
Imperial Parking	Parking lots	Parking lot and road area (sq. m)	137,957	0.00028	39.04
		# of permits sold (single occupant)	624,594		
	Mileage by parkers	# car kilometers	12,491,887	9.3E-05	1,159.25
Class survey	Drop off mileage	# car kilometers	1,723,745	4.6E-05	79.98
(BC Highways)	KUC use BC roads	total length of roads in BC (km)	42,279		
		total no. of registered vehicles in BC	2,686,423		
		average width of road (m)	15.249		
		area of roads (h)	64,469		
		road space per vehicle (h)	0.023998		
		Kwantlen-related use of cars	0.25		
		No. of Kwantlen-related cars	13123.16		
		Kwantlen-related road space	78.73		78.73
		Transportation (transit)			
Class survey		# transit users at Kwantlen	2,340		
	Mileage from transit	# passenger kilometers	8,424,000	0.00003	252.72

Total Campus Footprint (ha)					3,039.26
Footprint per FTE student					0.33
KUC footprint per FTE campus community member					0.30
(UTM footprint per campus community member)					1.04
KUC FOOTPRINT BY CONSUMPTION CATEGORY, AND COMPARISON TO UTM					
EF Category	KUC Footprint / Year (hectare)	KUC Footprint contribution (%)	(UTM footprint)	(UTM percent)	
Built-up land	33.38	1.10	7.83	1.26	
Water	4.80	0.16	1.64	0.21	
Transportation	1609.72	52.96	1463.65	18.72	
Paper	219.99	7.24	204.28	2.61	
Energy	878.50	28.91	5601.00	71.56	
Food	292.86	9.64	439.09	5.61	
TOTAL	3039.26	100.00	7827.30	100.00	

Source: Data collected by Geog 2250 and converted to appropriate units. KUC calculator adapted from UTM calculator by Chelsea Stewart and Jennifer Loo at the University of Toronto Mississauga. Details on source of data and calculations below.

Further details on footprint calculations

Reported below are further details our data sources, unit conversions and in some cases, the conversion factors for 'world hectares'. Where details concerning the latter are not reported here they are available in Chelsea Stewart and Jennifer Loo, 2005. User Manual for the UTM's Ecological Footprint Calculator, or Chelsea Stweart and Jennifer Loo, 2005. Ecological Footprint Progress Report, 2005 at <http://geog.utm.utoronto.ca/conway/ecofoot/mainframe.htm>.

CAMPUS POPULATION:

The (2005 unduplicated) count of full and part-time students is from "Three Year Data Summaries: Academic years 2003/2004 - 2004/2005", Kwantlen Office of Institutional Analysis and Planning at http://plaza.kwantlen.ca/sites/instanalplan.nsf/pages/factbooks_and_factsheets. Using this source, the estimated student Full Time Equivalent (FTE) total in 2005 was 10,376, extrapolated from 2002 ratios of full and part-time students.

(Other numbers on the campus population obtained include the following: The "Kwantlen University College Service Plan 2004/05 - 2006/07", available at the Kwantlen Office of Institutional Analysis and Planning web site at <http://plaza.kwantlen.ca/sites/instanalplan> states on p. 17 that the "Student FTE Performance Target" in 2004/05 was 8929, and in 2005/06 it was 9223. On the "Employment Opportunities" page of the Dept of Human Resources (accessed Feb 14/06) it states that "Kwantlen presently services 8767 student FTE on four campuses", but this is probably an old number. The Kwantlen University College "Environmental Scan 2004" available on Kwantlen University Office of Institutional Analysis web site (<http://plaza.kwantlen.ca/sites/instanalplan>) reports on p. 5-16 that the total number of employees as of April 16, 2004 was 1263 (6% admin, 64% faculty, 30% staff), making the number of faculty 808 and staff 455. The "2002 Factbook", Kwantlen Office of Institutional Analysis and Planning at http://plaza.kwantlen.ca/sites/instanalplan.nsf/pages/factbooks_and_factsheets reports there were 600 faculty and 560 other staff in 2002. The HR dept reported to Bill Burgess on March 6/05 that there are currently 1410 employees of Kwantlen, of whom 522 are regular faculty (most are full time), 44 are type 1 faculty (more than 50% load) and 305 type II (less than 50% load). The full and part-time faculty total would thus be 871, so the other staff (admin. and BCGEU

bargaining unit) total would be 539. Maureen Shaw, Vice-President of the Kwantlen Faculty Association reported to Bill Burgess on March 6 that the current faculty FTE numbers are as follows: regular 466.15 (actual number 494), faculty less than 50% FTE=65.51 (actual number 124), and faculty more than 50% FTE=19.94 (actual number 39). The total faculty FTE is thus 561.60, and the actual number of individuals is 657. In a March 8/06 email to Bill Burgess, Jillian Cochrane of the Kwantlen HR Dept. reported these numbers for full-time equivalent employees, as of Feb 2006: Administrators - 95 FTE's, Faculty - 577.48 FTE's, Staff - 323.28 FTE's (non faculty staff would therefore total 411 FTE).

FOOD:

Data is for the cafeterias in Surrey, Langley and Richmond in 2005, from a March 14 email to Bill Burgess from Gordon Barber of Compass Group, owner of Chartwells. The KSA's Oasis Lounge (formerly the Fishbowl) is not included.

According to the UTM calculator, the following foods have a world hectare footprint (EF) of:

1. Meat and poultry: 0.0069 ha-yr/kg
2. Seafood: 0.0045 ha-yr/kg
3. Vegetables: 0.0004 ha-yr/kg
4. Grain: 0.0017 ha-yr/kg
5. Dairy: 0.0011 ha-yr/kg
6. Fruits: 0.0005 ha-yr/kg

The EF of the food consumption in category X= (kg of category X) (conversion factor of category X).

PAPER CONSUMPTION:

See the text for details on the conversion factors and calculations.

Paper consumption by KSA is for the year 2004, as reported on Feb 15/06 by by Meenu of the KSA to Amy McLellan.

For the KUC Print Shop, Scott Gowen, Director of Materials Management reported in a March 1/06 email to Bill Burgess that printing paper consumption estimated for 2005 was over 20 million sheets of paper. He reported they began using 30% recycled fibre on Sept 1.

For the washroom paper, Barry Mohring, Kwantlen Facilities Manager reported in a March 6/06 email to Bill Burgess that paper towel consumption on all campuses in 2005 was 10,934 kg, and toilet paper consumption was 5,667 kg, in other words, 10.93 tonnes plus 5.67 tonnes = 16.60 tonnes. In a March 14 email to Bill Burgess Mohring reported that the paper towels contain 40% recycled fibre, but not the TP.

WATER:

Data courtesy of Tom Knox, Kwantlen Facilities Dept Energy Analyst (Feb. 20/06 email to Mathew Gauthier). According to the UTM calculator, the EF of cold tap water is 0.08m²-yr/100 L, after converting this number into m³, the conversion factor is 0.00008 ha-yr/ m³.

EF for water = (amount of water KUC uses in the period of a year) (conversion factor)

Energy

GAS:

The Kwantlen "Utility Billing Summary" provided by Tom Knox, Facilities Energy Analyst (in Feb 27/06 email to Bill Burgess) reports that KUC natural gas consumption (unadjusted) was 35,775 GJh.

http://www.neb.gc.ca/statistics/energyconversions_e.htm#NaturalGas reports that one GJ of energy is equivalent to .95 thousand cubic feet of natural gas at 1000 BTU/cf (in other words 950 cubic feet), while <http://www.onlineconversion.com/> reports that one hundred cubic foot of natural gas = 0.108 72 gigajoule, at which rate one GJ would equal 919.8 cubic feet of gas, slightly less than the 950 above. The http://www.neb.gc.ca/statistics/energyconversions_e.htm#NaturalGas page from the Government of Canada reports that 1 cubic meter of gas is equal to 35.301 cubic feet of gas at 14.71 psia and 60 degree F. So using the latter conversion rate, 35,775GJ of gas * 919.8 /35.301 = 984,262 cubic metres of gas.

HYDRO:

The Kwantlen "Utility Billing Summary" provided by Tom Knox, Facilities Energy Analyst in Feb 27/06 email to Bill Burgess reports that electricity consumption in 2005 (last 3 months projections based on previous year's total) was 8,062,504 KWh.

The "BC Hydro Annual Report 2005" reports on p. 116 that total energy generation was 11,311MegaWatts, of which 10,218 was hydro and 1093 thermal, or 90.34% and 9.66% respectively. 90.34% of the total power 8,062,504 KW of power consumed (see above) is 7,283,666.114 KW, and we divide this by 1,000,000 to get 7.284 Gigawatts of power consumed from hydroelectricity.

The "BC Hydro Annual Report 2005" reports on p. 116 that total energy generation was 11,311MegaWatts, of which 10,218 was hydro and 1093 thermal, or 90.34% and 9.66% respectively. 9.66% of the total power 8,062,504 KW of power consumed is 778,837.886, and we divide this by 1,000,000 to get .778 Gigawatts of power generated from thermal sources.

For off-Campus energy, the conversion factors were taken out of UTM user's manual. The manual uses Sharing Nature's Interest's conversion factors for different kinds of energy. They are:

Hydroelectric: 42.5 ha-yr/GWh

Coal: 174 ha-yr/GWh

These are the only two kinds of energy provided by BC Hydro.

$$\text{EF of Off-Campus Energy} = (\text{amount of energy X used}) (\text{conversion factor of X})$$

For on-Campus energy, the conversion factors for on-campus use of natural gas is 0.000465 ha-yr/m³

$$\text{EF of Natural Gas} = (\text{amount of natural gas used})(\text{conversion factor of natural gas})$$

Built-up land

Built land is land where productivity is lost as a result of different types of development. This includes roads, buildings and parking lots. Note that in this calculation we did not obtain information on the impermeable land area, thus this part of the calculation is not included.

BUILDINGS:

According to the Kwantlen web page, the total are of buildings on the 4 campuses is $7.58+5.53+2.94+13.12=29.15$ acres; according to <http://www.onlineconversion.com/area.htm> this is equal to 117,966 sq. meters. The UTM-provided conversion factor of buildings is 0.000283 ha-yr/ m².

EF of Buildings = (area of all four campuses)(conversion factor of buildings)

PARKING/ROAD AREA:

According to Kwantlen web page, the total area of road and parking lots on the 4 campuses is $9.38+4.79+18.88+1.04=34.09$ acres, and according to <http://www.onlineconversion.com/area.htm> this is equal to 137,957 square metres. The UTM-provided conversion factor of the parking lot and road area is: 0.000283 ha-yr/ m².

EF of Parking Lot and Road Area = (area of all four campuses)(conversion factor)

ROAD SPACE:

Our method for calculating Kwantlen-related use of BC road space is different from the UTM method (ours is simpler, relies on some guestimates, and, in retrospect, did not convert the resulting area to 'world hectares').

1. Calculate the area of the road space (in hectares)
2. Divide the area of road space by the total number of cars registered in BC= road space per vehicle (in hectares)
3. An assumption is made here. 25% of the Kwantlen related cars are used for Kwantlen purposes.
4. % of students who use cars as their primary method of transportation to school × total student population.
5. Multiply the results of lines 2, 3 and 4 together = EF of built up land for roads.

Car use

We estimated car mileage from on 1) the number of cars parked in Kwantlen parking lots, and 2) the campus population we estimated are dropped off by cars.

Bruce Engleton of Imperial Parking reported in a spreadsheet emailed March 8/06 to Bill Burgess that the number of parking tickets sold in January 06 was 7327 in Langley, 550 in Newton, 13, 947 in Richmond and 21,199 in Surrey, for a total of 42,023. He reported similar numbers would apply in the fall, but summer totals would probably be about 1/3 of those numbers. This would total 400,974 tickets per year. In addition he reported that 638 yearly permits are sold, 1401 one-semester permits and 206 two-semester permits. There are a total of 3201 parking stalls. If the permits were used 4 times per week and a semester is 15 weeks, the estimated number of trips they represent is

$$= (638*4*45)+(1401*4*15)+(206*4*30) = 624,594.$$

Instead of the UTM formula for car miles using survey data and what seems to be a different way of expressing parking tickets, our guestimated total car miles travelled from parking data is

$$= (\text{no. of car permit days from above})(\text{a guestimated 20 km average round trip distance}).$$

From drop-offs: Instead of using the UTM formula, our guestimate here is

$$= \text{the 2.7\% of the campus population being dropped off that is indicated by our survey} \\ * 4 \text{ days/wk times } 45 \text{ weeks per year} * \text{average trip of 20 km}.$$

Note the conversion reduces weight to half to reflect 2 drop-offs per car. The UTM calculator reports that the conversion factor for private car use is .0000928 hectare years per passenger mile.

$$\text{EF of car mileage} = (\text{passenger miles})(\text{conversion factor for private cars})$$

Transit use:

Geog 2250 carried out a simple, non random survey of transportation mode and distance to campus, with 144 student respondents. 19 or 13.2% used transit to get to an from campus. If this rate is applied to the campus population of 17,734 that would be 2,340 transit users. Assuming the average transit user lives 20 km away return trip and travels to Kwantlen 4 days a week times 45 weeks a year * no of transit users = passenger km. The UTM calculator reports that the conversion factor for transit users is .00003 hectare years per passenger kilometre.

$$\text{EF of transit mileage} = (\text{passenger miles})(\text{conversion factor for transit users})$$